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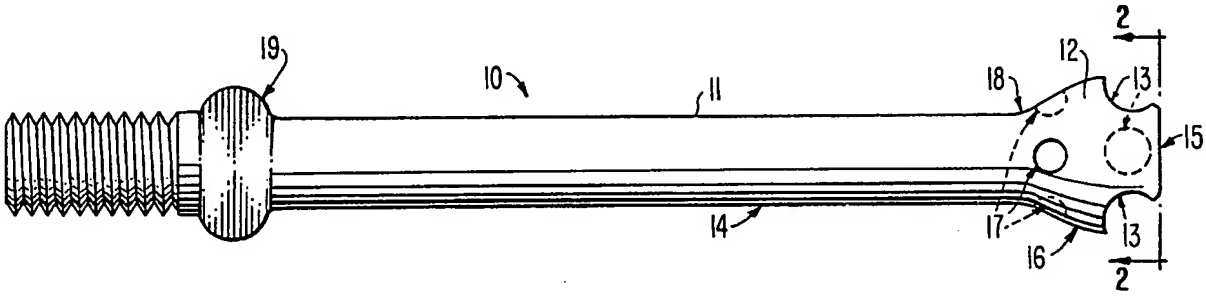

(57) Abstract

A perforate suction tip for removal of surgical debris with reduced clogging and with minimum trauma to tissue. Suction ports are arranged on the tip so that suction ports which remain unblocked when surgical debris lodges in other suction ports operate as a vacuum modulator facilitating the removal of the blockage. Further, the likelihood of blocking every suction port, thereby aspirating and damaging tissue, is greatly reduced.

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SURGICAL SUCTION DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to surgical suction devices for the removal of surgical debris.

Description of the Prior Art

Suction devices are used during surgical procedures to remove fluids and debris from the operating field. Various designs have been proposed for these devices. Typically, such devices include a tip which is inserted into the surgical field and a means, usually a conduit or a tube, for connecting the tip to a vacuum source. However, these known designs have proven unsatisfactory in some aspect.

The designer of a surgical suction device must consider various factors. The device must be easy and convenient to use and must minimize the amount of disruption to the surgeon. The time required to clear the field may impact both the total length of the procedure and the ability of the surgeon to identify problems within the field and complete the procedure. The length of the procedure affects both the surgeon and the patient. Procedures lengthened unnecessarily are unduly tiring to the surgeon and expose the patient to anesthesia for a prolonged period. Therefore, the time required to use the device must be minimized. Ease of use contributes to

minimization of the time required to complete the surgery and facilitates operation of the device by less trained personnel.

The device must also minimize the disruption of the patient's tissues. Aspects of disruption which must be considered include the size of the incision required and the trauma to tissue should it be aspirated into the device. The suction device should not require that the operating field be adjusted to accommodate it. Further, it is inevitable that tissue will be exposed to suction through inadvertence or inability to properly clear the field without impinging upon tissue. Therefore, the device should minimize tissue trauma by minimizing both the space required to use it and the tendency to injure aspirated tissue.

Further, the suction device must clear the field effectively. Typically, blood and other fluids, such as saline irrigating fluid and the like, will be present in the operating field. Solids and semi-solids such as coagulated blood, bone chips, excised tissue particles, and the like will also be present. All these materials must be removed from the operating field without extraordinary effort. The device must continue to operate effectively in the presence of these materials without requiring repeated and prolonged interruptions to unblock the device.

Various designs have been proposed to satisfy the above-described factors. For example, devices which control the amount of suction by moving the suction source relative to perforations in the tip are common. See, for example, U.S. 3,426,759 and U.S. 4,487,600. Some of these devices take advantage of relative motion to attempt to shear blockages of the suction tip, as in U.S. 3,308,825 and U.S. 4,400,168. However, these designs are, for

the most part, not commercially accepted because they are unduly difficult to operate. For example, the design in U.S. 3,308,825 requires that a locknut be loosened to allow the suction tube to slide within the suction tip and adjust the number of holes exposed to suction. The locknut must then be tightened to fix the location of the suction tube in relation to the suction tip. U.S. 4,400,168 requires that the thumb of the user's hand be utilized when varying the number of suction holes exposed and when shearing off blockages. The former procedure is complex while the latter requires a great deal of concentration and manual dexterity. Further, shearing apparatus typically require metal construction, thereby raising costs. Therefore, these designs are less than satisfactory.

Other devices vary the amount of suction available by sliding a suction tube within a perforated tip, as in U.S. 4,487,600, or by providing an opening between the vacuum source and the suction tip, as in German O.S. 1,491,755. However, both designs are flawed, the latter being unwieldy to operate, the former tending to clog and make the suction too strong when the suction is directed at only the holes closest to the tip.

Other designs, such as U.S. 3,963,028, while simple to manufacture and operate, are prone to clogging as the tip impinges upon tissue because the holes in the suction tip are relatively closely spaced. Designs which provide for atraumatic withdrawal of blood, such as U.S. 3,623,483, do not provide for adjustment of suction strength. Further, this design requires displacement of tissue within the field and a pool of blood from which to draw. Therefore, it is difficult to use such a design to completely dry a field.

Finally, other designers have circulated anti-coagulant in the tip. The anti-coagulant delivery device described in U.S. 3,955,573 is intended for use in autologous blood transfusion. Therein, anti-coagulant is delivered within a bulbous suction tip designed to thoroughly mix the anti-coagulant with the blood being aspirated. Therefore, the clotting tendency is almost immediately suppressed, thereby preventing clotting and blockages within the device. U.S. 2,804,075 discloses an anti-coagulant delivery system and teaches that when the suction holes become blocked, anti-coagulant accumulates within the tip and usually clears the blocked holes. Further, bone chips are said not be able to block the aspirator because the holes in the suction tip are smaller than the suction tube diameter. However, this does not explain why a bone chip might not block the suction tip itself nor how a blockage which is not affected by anti-coagulant, such as a fat globule or a piece of excised tissue, would be removed.

None of these devices have proven to be satisfactory. Therefore, it is an object of this invention to provide a surgical suction device which is convenient to use, clog resistant, efficient, and able to quickly clear an operating field of surgical debris while minimizing damage to tissue. It is a further object of this invention to provide a surgical suction device wherein the suction ports are disposed in a fashion which ensures that at least some of the suction ports will remain unclogged.

SUMMARY OF THE INVENTION

In accordance with these and other objectives, this invention relates to a suction device to be attached to a vacuum source for removal of surgical debris comprising an elongated section through

which the debris is aspirated. The elongated section contains a perforate end section in communication with a hollow central suction conduit which forms a passageway for the aspirated debris. The perforate end section has a perforate first surface portion extending from the end of the elongated section to the widest part of the perforate end section, and a perforate second surface portion extending from the widest part of the perforate end section to the distal end of the end section. Perforations form suction ports for the aspiration of debris through suction port conduits which communicate between the suction ports and the hollow central suction conduit. A hollow handle, which communicates between the vacuum source and the hollow conduit, defines a passageway for the aspirated debris.

The invention further relates to a suction device wherein the elongated section and part of the perforate end section are surrounded by a coaxially disposed perforate sleeve extending substantially from the end of the elongated section to the widest part of the perforate end section and having substantially the same size as the widest part of the end.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a preferred embodiment of a suction device used in the present invention.

Figure 2 is an end view of the suction device shown in Figure 1.

Figure 3 illustrates the assembly of the device together with a hollow handle according to the invention.

Figure 4 shows a preferred embodiment of the perforate sleeve intended to surround the elongated section and part of the perforate end section according to the invention.

Figure 5 is an exploded perspective view of the assembly containing the device, sleeve, and handle, of the present invention.

Figure 6 illustrates a surgical suction device, including a sleeve, according to the invention.

Figure 7 illustrates an alternative embodiment of a suction device.

Figures 8 and 9 illustrate the relationship of the intersection of suction port conduits with the hollow central suction conduit.

Throughout these drawings, like numbers are utilized to identify like parts.

DETAILED DESCRIPTION OF THE INVENTION

It has been discovered that a surgical suction device can be made convenient to use, clog resistant, efficient, and able to quickly clear an operating field of surgical debris while minimizing damage to tissue by disposing suction ports on a first surface portion of a perforate end section of the device so that these suction ports act as a vacuum modulator when suction ports on the second surface portion of the tip become clogged. Thus, debris which becomes lodged in suction ports on the second surface portion is not subjected to the entire vacuum because other ports remain open. Similarly, tissue is not traumatized by being strongly aspirated into the suction ports.

Lodged debris can often be dislodged simply by moving the device or rotating it within the operating field. Similarly, if the surgeon desires to remove a large particle from the field, the device simply can be removed from the field and wiped on another surface. The particle is easily removed from the suction ports because the vacuum is modulated by the non-plugged suction ports. Thus, the

strength of the vacuum is automatically regulated without the need for a separate vacuum adjustment technique, such as the ability to expose additional suction ports in the tip. Further, debris which does become lodged in a suction port can be removed without the need for a shearing or cutting device.

It has also been discovered that the fraction of the total suction port area which is on the first portion of the end affects the self-regulation of vacuum distribution.

It has been further discovered that to orient the suction port conduits from the first surface portion, so that they intersect the hollow central suction conduit at approximately equal distances from the distal end and are disposed generally toward the distal end of the perforate end section, is desirable because this orientation creates turbulence at that intersection. This turbulence tends to ensure that particles aspirated into the hollow central suction conduit do not lodge in the intersection of the hollow conduit and the suction port conduits.

Figure 1 illustrates a preferred embodiment of device 10 comprising elongated section 11 containing hollow central suction conduit 14 and perforate end section 12 through which hollow central suction conduit 14 continues. As illustrated, perforate end section 12 is bulbous. However, the perforate end of the tip need not be bulbous. Perforate end section 12 can have any enclosed shape which provides a first surface portion 16 extending outwardly from the end 18 of elongated section 11. Hollow central suction conduit 14 continues through perforate end section 12. First surface portion 16 can be of any shape which is narrow at one end and widest at the other. An example of another suitable first surface

portion is a frusto-conical section. Those skilled in the art are familar with other suitable first surface.

First surface portion 16 need not be oriented on the axis of hollow central suction conduit 14. Instead, first surface portion 16 could be oriented at an acute angle from the axis of hollow central suction conduit 14. Figure 7 is an illustration of a tip with such an orientation. Further, hollow central suction conduit 14 need not be straight. It may have any curve or compound curves desired.

Figure 2 depicts an end view of perforate end section 12, clearly illustrating a planar face 15 and the relationship between suction ports 13 in the second surface portion of perforate end section 12 and suction port 20 in planar face 15 of the second surface portion. The embodiment illustrated therein has three suction ports 13, each of which is substantially the same size, symmetrically placed about second surface portion of perforate end section 12, and one suction port 20 centered in planar face 15. For the purposes of this invention, the suction ports 13 in the second surface portion of perforate end section 12 should be of the same size and these suction ports, together with suction port 20 in planar face 15, if the second surface portion has a planar face, should be symmetrically placed about the face and the second surface portion of the end, thus ensuring even distribution of suction.

Although the size of the suction ports is not critical, certain criteria should be considered when sizing the suction ports. As already described, the suction ports on the second surface portion of the end should be of the same size and symmetrically placed to ensure even distribution of the vacuum. Within these constraints, the number of suction ports is theoretically unlimited. However,

practical considerations establish limits on the suction port size and placement. Although two suction ports could be symmetrically arranged on the second surface portion of perforate end section 12, the operability of the device would be reduced. Therefore, the fewest preferred number of suction ports in the second surface portion of perforate end section 12 is three.

The suction ports communicate with hollow central suction conduit 14 via suction port conduits. Each suction port conduit preferably has the same cross-sectional size and shape as the suction port with which it communicates. However, the suction port conduit can have any cross-sectional size and shape which is not smaller than the cross-sectional size and shape of the associated suction port. This limitation ensures that solid or semi-solid particles of debris aspirated through the suction port will thus also be aspirated through the suction port conduit.

Suction port conduits need not be any particular length. Figure 8 illustrates the relative length of suction port conduits 23, in communication with suction ports 17 in first surface portion 16, and suction port conduit 21, in communication with suction port 20, in a preferred embodiment of this invention. Although suction port conduit 21 preferably is short, as illustrated in Figure 8, it could be extended further into the interior of perforated end section 12.

The maximum number of suction ports is limited by the ability to manufacture a device having sufficient structural strength and by the minimum desired suction port size. The latter criterion establishes the practical limitation for the purposes of this invention, as the suction ports must be large enough to aspirate at least some of the non-fluid debris. This debris, such as fat globules,